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idle mode.

Detailed Description Text - DETX (186):
At step 746, the UF pump 244 is turned on and water is directed from UF tank 244 though the dialysate circuit 400 back through the pyrogen/ultrafilter 234.

Detailed Description Text - DETX (188):
At step 750, water is rinsed in the tank 202 via sprayer 205. At step 752, water is directed from the tank 202 to dram. At step 754, RO water is sent to the tank 202. At step 756, the blood pump 458 is run in reverse at 75 ml/min. Water is directed through the dialyzer 404 and back to the tank 202 through the chemical ports in the loading platform 250. At step 758, water is drained from the tank 202. [redacted] Water is directed from the tank 202 through the dialyzer 404 and the extracorporeal circuit 400 and then to drain. The system waits until the tank 202 level sensor reads 1 and the flow meter 241 reads less than 300 ml/min.

Detailed Description Text - DETX (190):
After the disinfection mode, the system enters a dialysate preparation sequence 706, described in detail in FIG. 19. At step 717, the process described with step 742 above is performed. At step 719, the RO filters 100 is placed in a produce water mode. The RO alarm monitoring RO conductivity in cell 106 is activated. RO filtered water is then directed to the tank 202. Pump 212 is run at top speed in the forward direction. The tank 202 is placed in a recirculation and deaeration mode, in which warm circulates out the tank 202 through degassing line 209, through valves V9 and 220 and back to the tank via valve 232 and line 231 and valve V15. The temperature at thermistor 230 should read a temperature of 30 degrees C. The UF tank 244 is filled with 500 ml of water using the UF pump 242. The tank 202 is filled with reverse osmosis water up in the level at which chemicals are added to the tank 202, and then the RO filter 100 is turned off.

Detailed Description Text - DETX (191):
At step 721, the pressure sensors 500A-C in the extracorporeal circuit are calibrated against pressure sensor 410 in the dialysate circuit. Pressure variations in the dialysate circuit 402 are achieved by moving volumes of fluid between the tank 202 and the ultrafiltration tank 244, with the introduction of fluid into the tank 202 causing an increase in pressure. Similarly, pressure variations in the extracorporeal circuit 400 are achieve by introducing additional volumes of fluid into the extracorporeal circuit via disinfection manifold 494. This calibration test is advantageous in that it permits the use of disposable, off the shelf pressure transducers to be used in the extracorporeal circuit 400. It also permits high accuracy of the monitoring of the blood pressure in the extracorporeal circuit 400 during dialysis. To

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[11] Patent Number: 5,702,606

[45] Date of Patent: Dec. 30, 1997

(List continued on next page.)

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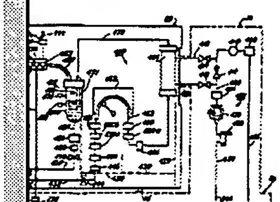
Geddes et al., *Programmable Machine for Dialyzer Reuse*, Med. & Biol. Eng. & Comput., Nov. 1980, pp. 765–771.

Primary Examiner—John Kim
Attorney, Agent, or Firm—McDonnell Boehnen Hulbert & Berghoff

[57] ABSTRACT

A method is described for priming a dialyzer placed in an extracorporeal circuit of a hemodialysis machine in situ. The method comprises the steps of substantially filling the extracorporeal circuit and the blood side of the dialyzer with fluid (such as dialysate, RO water, saline, etc.), and inducing pressure pulses in the fluid. The pressure pulses cause air bubbles from the blood side of the dialyzer to be sheared off the dialyzer membrane. The air bubbles are then conducted from the dialyzer and removed from the extracorporeal circuit. Backfiltering of fluid across the dialyzer from the dialysate circuit into the extracorporeal circuit is performed in synchrony with the pressure pulses to assist in the shearing off of air bubbles from the blood side of the dialyzer membrane.

6 Claims, 40 Drawing Sheets



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559 by virtue of threaded engagement of flange 561 of female luer 559 with threads 560 of male luer 550 and rotational movement of locking hub 556 relative to female luer 559. In FIG. 37D, an alternative construction is shown in which the locking hub 556 is a separate spinning hub piece that snaps over a circumferential ridge 555. Air vents out of the hub 556 by virtue of the clearance 553 between the locking hub and the integral tube 557.

Detailed Description Text - DETX (144):

The pressure sensors 500A, 500B monitor the pressure in the arterial line 432. If for some reason the arterial fistula needle gets accidentally positioned against the wall of the patient's blood vessel, the pressure will generally drop. The CPU 616 (FIG. 16) monitors the readings of sensors 500A, 500B and, if the pressure drops, it prompts the patient to move about to free up the needle or adjusts the blood pump 458 to bring the pressure to acceptable limits.

Detailed Description Text - DETX (145):

The efficiency of a dialyzer in removing toxins is maximized if the dialysis time is made as short as possible. The faster clearance of urea requires a faster flow rate of the patient's blood. We achieve a faster flow rate by taking advantage of a lower limit of pressure to be monitored by pressure sensor 500B that is safe for conducting dialysis. This pressure limit would be set by the patient's physician. As long as the pressure is above this limit, the pump rate of the blood pump 458 is gradually increased. If the pressure drops below the limit, the blood pump is slowed or stopped if the pressure fails to rebound. When the pressure rebounds, the pump is speeded up. This feedback control of a blood pump 458 by pressure monitors in the arterial line will permit the system to generally shorten the dialysis time, to inform the patient of the expected time for dialysis, and to update the time based on any significant slowing or speeding of the blood pump 458. During this process, the backup pressure sensor 500A provides data in case of a malfunction in sensor 500B. Ordinarily, the pressure sensors 500A and 500B have the same readings. The pressure sensors 500A-C are calibrated against the reference sensor 410 in the dialysate circuit 402 as described below in conjunction with the pressure test of the extracorporeal circuit.

Detailed Description Text - DETX (146):

The blood sensors 446 and 486 are of the same basic design as the blood leak detector, but without the beam splitter and reference photodetector. The sensors 446 and 486 serve two purposes: (1) to detect blood when blood is rim introduced into the extracorporeal circuit 400, thereby permitting calculation of the time elapsed during dialysis, and (2) permitting automatic rinse back control by automatically ending the rinsing back of the blood when the light transmission levels detected by the sensors 486 and 446 rises to a threshold value. As dialysate (or saline) is pumped through the dialyzer 404 during

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[57] ABSTRACT

6 Claims, 60 Drawing Sheets